An Investigative Analysis on Recycled Aggregate Concrete Using PP Fibers

Prof. Harsh Gupta[1] Prakash Gautam[2]
[1]Professor & Head of the Department [2]Scholar
[1,2]Department of Civil Engineering
[1,2]JNCT Rewa M.P., India

Abstract— In this paper we have examined about the utilization of Recycled Aggregate Concrete in the substantial and the impacts on its compressive strength by dynamically supplanting the Natural Aggregate (NA) by Recycled Aggregate. It is the test concentrate on of Recycled Aggregate Concrete (RAC) when it is contrasted and the Natural Aggregate because of its properties. Shapes having measurement 150x150x150 mm3 were casted utilizing Recycled Aggregate by supplanting the Natural Aggregate by 0%, 25%, half and 75% and relating consequences of compressive qualities and rigidity were noted. The compressive strength and elasticity were noted by squashing the shape and chamber in the wake of relieving at 7, 14 and 28 days individually with water concrete proportion of 0.5 and proportion blend of M20 and it was discovered that exhibition of cements with 0% and 25% substitution of Natural Aggregate by Recycled Aggregate were very like ordinary cement however with half and 75% substitution, the strength of coming about concrete was diminished. The Recycled Aggregate cement can be utilized in low ascent structure, asphalt plan, waste design, street development and so forth this fill additionally resolve natural issues raised because of unloading of destruction trash and development squander.

Keywords: RAC, PP Fibers, Workability, Compressive Strength, Tensile Strength, Concrete

I. INTRODUCTION

The investigations on the utilization of reused aggregate in various structures have changed the development business generally. Different solid and excellent designs are being assembled now days by utilizing reused substantial total in organization with Natural Aggregates to meetthe prerequisite of the 21st century.

A. CONCRETE

Concrete is a mixture of material which consist of aggregate, sand, water and cement which harden with time. Some-time suitable admixtures are added with concrete to obtain required physical and chemical properties.

The use concrete has been traced some thousand years back. In earlier concrete, the constituents of concrete were different. It was made up of fine aggregates, coarse aggregates and lime. Later on lime has been replaced with the cement. Now a day, concrete is used with steel structure to give additional strength to the structure. Type of concrete depends upon its constituents therefore required quality of concrete for any application can be obtained by substituting the constituent. Based on properties, concrete can be used for different purpose. Itis used in high rise and low-rise building, R.C.C, P.C.C, bridges, foundation work etc.

B. RECYCLED CONCRETE

The use of Recycled Aggregate Concrete in development has begun since end of The Second Great War by crushed cement. During the 1970s, the United States started to once again introduce the utilization of RAC in non-structure uses, for example, fill materials, establishments, and base course. As of now India has taken significant drives in fostering the foundation like structures, thruways, power projects and mechanical design and so forth With the destruction of deserted design the increment in trash is an intense danger, causing natural issues. To secure the climate this destruction flotsam and jetsam can be squashed to shape Recycled Aggregate. On concentrating on the idea of this Recycled Aggregate it has been discovered that by supplanting regular total with Recycled Aggregate somewhat the property of substantial remaining parts unaltered. Presently a day Recycled Aggregate is being utilized in fostering the foundation like expressways, structures, modern designs and force projects.

C. OBJECTIVES

The main objects covered in this project work are mentions as follows:

- To study the strength and property of RAC.
- To reduce the cost of constructions.
- To make environment free from demolished concrete waste.
- To optimize the maximum use of RAC.

II. LITERATURE REVIEW

We have referred the literature work done by Indian as well as some foreign scholars in the field of using Recycled Aggregates obtained from the demolition of old structures and construction wastes along with Natural Aggregates in the concrete mixture.

A. PROF. CHETNA M. VYAS: (JAN.2013)

In this research paper the Recycle Aggregates are comprised of crushed, graded, inorganic partially processed materials that have been used in the construction. In studying the basic properties of Recycle Concrete, it is also compared with the Natural Aggregate to find out thecompressive strength by using M20, M25, M30 grade of RAC by replacing 100% of the natural concrete. This paper presents status and utilization of Recycle Coarse Aggregate in India and its future need is discussed.

These are the various comparison of Recycle Concrete.

Quality: RAC has change in physical and chemical quality. RAC is formed by crushed materials so it can be change in shape and size.

Density: The density of recycled concrete aggregate is lower than the natural aggregate.

Density of Recycle aggregate is lower than the fresh aggregate because of the porous and less dense residual mortar lumps that is adhering to the surface .When particle size is increased, the volume percentage of residual mortar will increases too.

Strength: The strength of recycled aggregate is lower than natural aggregate because of the weight of recycled aggregate is lighter than natural aggregate.

After detailed study of the result and analysis the following conclusion were made.

1) The experimental result show that the early compressive strength of concrete made of natural aggregate and recycled coarse aggregate is approximately same.
2) The slump test indicates a decreasing trend of workability when the percentage ofrecycled aggregate are increased.
3) All the experimental result so the Recycle aggregate can be used in concrete with 40%replacement of natural course aggregate.

B. R. KUMUTHA AND K.VIJAI:

In this journal the properties of concrete containing recycled aggregate were investigated. Recycled aggregate consist of crushed concrete from the demolition wastes available locally. Laboratory trials were conducted to investigate the possibility of using recycled aggregates asthe replacement of natural coarse aggregate or fine aggregate in concrete. A series of tests work carried out to determine the density, compressive strength with and without Recycle aggregate. Natural coarse aggregate in concrete was replaced with 0%, 20%, 40%, 60%, 80%, and 100% of crushed concrete aggregate.

We found the research on the usage of waste construction material is very important as the quantity of waste material is gradually increasing as a result of increase in population and increase in urban development. In the experimental investigation it was found that the Recycle aggregate will influence much in hardness properties of concrete as the percentage of crushed concrete coarse aggregate is increased, strength of the concretes decreased. Its application are structural elements like concrete slab beam, column etc. Apart from this more study is required to understand the long term durability characteristics of concrete made usingRAC.

C. HIREN A.RATHOD: (FEB.2013):

In this journal the use of RAC in civil construction work reduce environmental pollution and reduce the cost of production of natural resource as well as solving the problem of construction waste management by putting in use of this waste.

We studied the result showed reduction in strength of concrete with increase in percentage replacement of RAC. We can say that up to 20% RAC utilized for economical and sustainable development of concrete.

In this research the RAC increases water demand, reduction in workability and reduced strength compare to the CA and also show in the result reduction in strength of concrete with increase in percentage replacement of RAC.

D. YONG P C AND TEO: (AUG 2009)

The main aim of the research project is to utilize recycled concrete as coarse aggregate for theproduction of concrete. It is essential to know whether the replacement of RAC in concrete is inappropriate or acceptable. Three types of aggregates were used in this project which includes natural coarse aggregate, natural fine aggregate and RAC. Natural coarse aggregate used is micro-tonalite with maximum size of 25 mm. Natural fines aggregate used was sand and RAC used was crushed concrete from tested concrete cubes. Test are carried out on these aggregates to determine the specific gravity, water absorption, bulk density moisture content and sieve analysis. After testing, a mix design is produced in accordance with the properties obtained from test results. Concrete is then produced with replacement of 0%, 50% and 100%of RAC as well as 100% replacement of saturated surface dry RAC with same mix proportion. Tests conducted on this concrete include the slump of fresh concrete. For hardened concrete, 28 days air-dry density, compressive strength, split tensile strength and flexural strength was determined. Tests were conducted at the duration of 3, 7, 28 and 56 days. The results of all duration were reported as an average. The engineering properties of RAC were also compared to those of the reference concrete.

III. METHODOLOGY & RESULTS AND ANALYSIS

In this chapter we will be discussing about the results which are obtained by various tests performed on concrete having recycled aggregate as its component in different proportions.

– For the specified max size of aggregate of 20mm the amount of entrapped airin the wet concrete is 2%

$$V = (W + C/S_C\ 1/P\ X\ (f_a\ /S\ f_a))\ 1/1000$$

V = Absolute volume of fresh concrete {Gross volume ($1m^3$) minus the volume of entrapped air}S_C = Specific gravity of cement

W = Mass of water

P = Ratio of fine aggregate to total aggregate byabsolute F_a, C_a = total mass of fine aggregate and coarse aggregate kg/m^3

S_{fa}, S_{ca}= Specific gravity of saturated surface dry of fineand coarse aggregate respectively

A. FOR FINE AGGREGATE:

$$V = (W + C/S_C + 1/P\ X\ (f_a\ /\ S\ f_a))1/1000$$

$$(1-0.02) = (188.79 + (377.58/3.15) + (1/0.315)\ X$$

$$(F_a\ /\ 2.60))\ X\ 1/1000 F_a = 549.83\ kg$$

B. FOR COURSE AGGREGATE:

$$V = (W + C/S_C + 1/(1-P)\ X\ (C_a\ /S_{ca})\ )\ 1/1000$$

$$(1-0.02) = (188.79 + (377.58/3.15) + (1/1-0.315)\ X\ (c_a/2.65))\ X\ 1/1000$$

C_a = 1220.61kg.

C. Mix proportional on basis of weight:

Water	Cement	Fine aggregate	Coarse aggregate
188.79	377.58	549.83	1220.61
0.50	1	1.456	3.25

– Actual quantities required for mix per bag of cement the mix is 0.50:1:1.456:3.25for 20 kg cement.

Quantity of material are worked out as

1) Cement : 1x 20 =20 kg.
2) Sand : 1.456x20 =29.12 kg.
3) Coarse aggregate : 3.25 x 20 = 65 kg.
4) Water :0.5 x 20= 10 kg.

– For w/c ratio 0.5, quantity of water required per bag of cement =10 lit.Extra quantity of water considering free moisture above SSD condition:

1) For coarse aggregate , extra quantity of water to be added for

Absorption = 0.5% of 65
= 0.325 lit.

2) For fine Aggregate, quantity of water to be deducted for free moisture present

= - 2% of 29.12
= - 0.5824 lit.

3) Actual quantity of water required to be added
= 10 +0.325- 0.5824
= 9.74 lit.
4) Actual quantity of sand required after allowing for mass moisture
= 29.12 +0.5824
= 29.71 kg.
5) Actual quantity of coarse aggregate
= 65-0.325
= 64.68 kg.

1) TEST RESULT OF CEMENT

a) FINENESS TEST

It is the ratio of the weight of cement which passes through the IS sieve no.9 by gentle sieving to the total weight of sample cement.

Fineness of Cement (%) = (R2 / R1) x 100
R1 = Weight of sample taken
R2 = Weight of residue after sieving
= (0.4/10) X 100
= 4

2) CONSISTENCY TEST:

It is the water content required to produce a cement paste of standard consistency.

Standard consistency (%) = (Weight of water added/weight of cement) x 100
= (130 / 500) X 100
= 26

D. INITIAL SETTING TIME:

It is the duration in which cement loses its plasticity. Using PPC cement, initial setting time is1 hour 45 min.

E. FINAL SETTING TIME:

It is the time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does not make any impression. Using PPC cement, initial setting time is 4 hour 5 min.

F. COMPRESSIVE TEST

It is the ratio of the load per unit area.
Compressive strength = load / cross sectional area of specimens n/mm^2
= (233 x100)/ 250
= 93.2 Mpa

G. TEST RESULTS OF COARSE AGGREGATE

1) SIEVE ANALYSIS OF COURSE AGGREGATE:

The aggregate which passes through 75 mm IS sieve and entirely retain on 4.75 mm IS sieve is known as coarse aggregate.

S. No.	I.S. Sieve No.	Weight Retained (g)	Cumulative Weight Retained(g)	Cumulative% Retained on Each Sieve	% Passing	Remarks %
1	40	00	00	00	100	FM=3.28%
2	25	220	220	4.4	95.6	
3	20	2130	2350	47	53	
4	16	1670	4020	80.4	19.6	
5	10	835	4855	97.1	2.9	
6	4.75	115	4970	99.4	0.6	
7	Pan	00	0	0	0	

Table 3.5.1: Sieve analysis of course aggregate:

Fineness Modulus of Coarse Aggregates:
FM = Sum of cumulative % retained = 3.28 %100

H. TEST RESULT OF RECYCLED

CONCRETETES RESULT OF IMPACT VALUE
RAC Impact Test Value:

S. No.	Total wt. of dry sample (A) in gm	Wt. of aggregat eretained 2.36 mm sieve in gram	Wt of aggregat epassing 2.36 mm sieve in gm (C)	Aggregate impact value=(C/A)X100
1.	300	180	120	40.00
2.	2000	1350	650	32.50

Aggregate impact value RAC (%) = 36.25

Grade of concrete	RAC (%)	Slump (in mm)
M-20	0%	65
M-20	25%	48
M-20	50%	33
M-20	75%	25

From the above results it can be concluded that with increase in RAC percentage the workability of concrete increases.

IV. RESULT ANALYSIS:

The results obtained from Graph 1 the slump cone test of Recycled Aggregate concrete are illustrated in the above graphs. The result shows that the RAC has good workability when we are adding 25-30% of recycled aggregate in the concrete.

A. COMPRESSIVE STRENGTH TEST:

Load failure of Cube:

Replacing %	Failure load after 7 days (KN)	Failure load after14 days (KN)	Failure load after28 days(KN)
0%	370	530	625
	350	544	628
	368	527	631

25%	350	524	589
	366	519	583
	356	511	575
50%	309	352	413
	302	361	423
	298	355	434
75%	244	298	301
	241	289	307
	252	271	306

In the case study the use of high percentage of RAC is replaced 0%, 25%, 50%, and 75% by weight of NA. A concrete mix the prepared in laboratory with water to binder W/C ratio and cement content 0.45 and 20 kg respectively.

1) Compressive Strength of Cubes.

Concrete mix	7-days Comp. strength (MPA)	Average Comp. Strength (MPA)	14-days Comp. strength (MPA)	Average Comp. strength (MPA)	28-days Comp. strength (MPA)	Average Comp. strength (MPA)
0%	16.4 15.6 16.3	16.1	23.5 24.1 22.5	23.3	27.7 27.9 28.0	28
25%	15.5 16.2 15.8	15.8	23.2 23.0 22.2	22.8	26.5 25.9 25.5	25.9
50%	13.7 13.4 13.2	13.4	15.6 16.0 15.7	15.7	18.0 18.8 19.2	18.6
75%	10.8 10.7 10.2	10.5	13.2 12.8 12.0	12.6	13.3 13.6 13.6	13.5

B. TEST RESULT FOR TENSILE STRENGTH:

Replacing %	Failure load after 7days (KN)	Failure load after 14 days (KN)	Failure load after28 days (KN)
0%	39.22	50.43	56.04
25%	37.62	48.37	53.74
50%	28.79	37.02	41.13
75%	21.47	27.60	30.67

Table 3.8.1: Load failure of Cylinder

1) Tensile Strength of Cylinder

Concrete mix	7-days Tensile Strength (MPA)	Average tensile Strength (MPA)	14-days Tensile Strength (MPA)	Average Tensile, Strength (MPA)	28-days Tensile Strength (MPA)	Average Tensile. Strength (MPA)
0%	2.70 2.77 2.70	2.74	3.54 3.51 3.51	3.52	3.88 3.95 3.90	3.91
	2.64		3.33		3.72	
25%	2.62 2.63	2.63	3.41 3.40	3.38	3.77 3.76	3.75
50%	2.02 2.03 1.98	2.01	2.61 2.56 2.57	2.58	2.87 2.91 2.83	2.87
75%	1.47 1.55 1.48	1.50	1.94 1.91 1.94	1.93	2.12 2.18 2.12	2.14

V. CONCLUSION

Based on the experimental work performed under the valuable guidance, the behavior of concrete having recycled aggregate as a substitute was studied closely and following conclusions have been drawn:

1) The water absorption capacity of RAC is higher as compared to that of NCA due to sub-quality of recycled aggregate.
2) The workability of RAC is comparable to NCA if the proportion of recycled aggregate in the concrete is up to 25%. On further addition of recycled aggregates in the concrete, its workability decreases. This is because of low density of aggregate resulting in higher water absorption.
3) The Compressive Strength of RAC where aggregate is replaced by Recycled Aggregate with proportion 25%,50%,and 75% and the compressive strength on 28 days curing is 28 Mpa, 25.9 Mpa, 18.6 Mpa 13.5 Mpa respectively.

   The result of Compressive Strength shows that the Compressive Strength of Concrete is reduced as the percentage of Recycle Aggregate increases.

   Though the Compressive Strength is keeps on reducing still we can say 25% replacement is better because it reduces the cost of construction by giving the strengthof M-25

   The Compressive Strength of the RAC is comparable to NCA if the proportion of Recycled Aggregate added is up to 25-30%. After this, decrease in the Compressive Strength is observed.
4) The Tensile Strength of RAC where Aggregate is replaced by Recycled Aggregate with proportion 25%,50% and 75% and the Tensile Strength on 28 days curing is 3.91 Mpa, 3.75 Mpa, 2.87 Mpa 2.14 Mpa respectively.

   The result of Split Tensile Compressive Strength shows that strength of concrete is reduced as the percentage of Recycle aggregate increases. Though the Split Tensile Compressive Strength is keeps on reducing still we can say 25% replacement is better because it reduces the cost of construction by giving the strength of M-25.
5) By using the Recycled Aggregate in the Concrete the of dumping of demolition debris and construction waste is resolved to a great extent.
6) It will helps in keeping our environment clean and safe. It will help in maintaining thefertility of soil which in turn is good for vegetation and maintain the level of ground water.
7) From the outcomes of the experimental work it can be advised that upto 25-30% of RAC can be used for

construction of low rise buildings, pavements, roads, drainage structure.

8) In this project work we have used both the RAC and NCA which we have purchased locally from the markets. There is significant different in their prices. The cost of aggregate purchased from market and how RAC decreases total cost of project is illustrated here.

Table 19 Three concrete mix with 20 kgs. of Aggregates was prepared with 25% RAC, 75 % NCA and other ingredients purchased from 3-different markets.

From above cost realization it is clear that since the prices of all other ingredient and labor cost are same across all markets, by using only 25% of recycled aggregate, investors can make good profit.

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[8] R. Kumutha and K.Vijai. Research Scholar, Civil Engineering Department, School of Engineering, Cochin University of Science and Technology, Kochi, Kerala, India 2M-Tech student, Computer Aided Structural Engineering, Civil Engineering Department. With reference to 2.2.2

